Letters to the Editor.

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The Age of the Earth.

AT the discussion on the age of the earth at Edinburgh we were unfortunately prevented from hearing Dr. Jeffreys's contribution owing to lack of time. I have, however, read it with interest in NATURE of October 27. My only object in writing now is to demur to an allusion in it: "Lord Rayleigh's suggestion that the earth must be becoming hotter." The words I used were carefully qualified, and I do not think that I can do better than quote them: "If [the radio-active materials present in the earth] are generating more [heat than is now leaking out from the earth] (and there is evidence to suggest that they are), the temperature must, according to all received views, be rising."

I appreciate the difficulty of such a supposition as clearly as Dr. Jeffreys. RAYLEIGH.

Terling Place, Witham, Essex, October 31.

Inheritance, Mendelism, and Mutation.

IN NATURE (August 18, pp. 780–84) appears an article by Prof. Goldschmidt on "The Determination of Sex." The author supposes he is dealing with inheritance. At any rate, Mendelians suppose they deal with inheritance, and he declares "we may safely say that to-day, in the light of Mendelism and the work accomplished in the realms of cytology, the problem is solved as completely as the methods of biology permit." Very probably the odd chromosome of which he writes has influence; but very massive evidence indicates that sex is determined mainly, not by the nature, but by the nurture of the individual—by such things as hormones from the sex-glands, food, temperature, and the like. In other words, it is certain that both sets of sexual characters are *inherited* by the individual, but, except in true hermaphrodites and in "intersexuality" (abnormal blending), only one set is *reproduced*. Male is undeveloped female, and *vice versa*. There is alternative patency and latency, alternate *reproduction*, not alternate *inheritance*. But the alternation is often irregular. For example, in aphides, during a long and indeterminate series of generations, the male characters are latent.

So far as it is possible to judge from ordinary experience of life, offspring appear to blend most parental characters, as is best seen when, within limits, the parents are much unlike. For example, when blue-eyed Scandinavian crosses with black-eyed negro, the result is a mulatto, who, though he may incline more to one parent than to the other, is conspicuously a blend. Mulattos, mated together, continue to breed true, but if succeeding matings be with pure white the touch of the tar-brush grows fainter generation after generation. In sexual characters and eye-colour there is, however, no apparent blending. The child is male *or* female, with, almost invariably, black eyes—black dominating over blue. But do sexual characters and eye-colour furnish evidence that there is here no blending? Is it reasonable to expect the male characters to blend with female characters? Is this what happens in the case of truly hermaphrodite animals and plants when both sets of sexual organs are patent? For example, do stamens blend with pistils? Plainly, except in cases of "intersexuality," when the male and female characters do blend more or less, if there is any blending, it is between the patent male characters of the one parent and the latent male characters of the other. So, also, with the female characters.

Similarly with eye-colour. With at least rare exceptions, mulattos, no matter for how many generations interbred, have black eyes. The black continues dominant. But if each succeeding generation mates with white, then at length blue eyes *suddenly* appear. How could this happen if the inheritance, not merely the reproduction, were alternate? The black would then remain as dominant in the octoroon as in the mulatto. But with the inheritance of both characters and the reproduction of only one the thing is comprehensible. Each reinforcement of blue then weakens the dominance of the black until at last blue becomes dominant. Much the same appears to happen in the case of human monstrosities—idiocy, hare-lip, club-foot, and the like. Here normality is dominant until the conditions of nurture are in some way altered—*e.g.* by the reinforcement of the monstrous strain. Apparently, then, the long latency of the blue eye-colour is comparable with the similar latency of the male characters in aphides.

What is a mutation? As well as I am able to judge from literature, it is a character the reproduction of which is Mendelian, and which, very commonly, is of "wide amplitude," a "sport." It has been said that, "unlike fluctuations which are responses to nurture, mutations have representatives in the germ-plasm." But this is merely a misuse of language, for since all characters are products of germinal potentiality and fitting nurture, all must be equally germinal and somatic. As already indicated in a former communication (NATURE, August 25, pp. 808–10), whenever we are able to observe natural selection actually at work, its choice is obviously among fluctuations, not mutations. Thus every shade of susceptibility to tuberculosis may be observed; for in the same surroundings some individuals resist disease altogether, others recover more or less quickly from illness, while others die after long or short illnesses; in different localities the stringency of selection is different; races have been afflicted by the bacillus during diverse durations of time, and every race is resistant in proportion to the length and severity of its past experience. Moreover, the inheritance is blended; thus half-breeds (*e.g.* Europeans crossed with Asiatic, negro, and American Indian) are susceptible in proportion to the blended susceptibilities of their ancestors. For example, Eurasians commonly survive in the cities of the temperate zones, where American half-breeds almost invariably perish. It is probable that few of the American Indians and Maoris and their half-breeds that came to and survived the Great War have returned home to live.

On the other hand, as Darwin noted, man "often begins his selection by some half-monstrous form, or at least by some modification prominent enough to catch the eye, or be plainly useful to him." Man is in haste to get results, and usually cannot observe small differences in races other than his own. Thus even the natives of China seem to an Englishman newly arrived as like as peas in a pod—as doubtless they are. In some cases, however, man is obliged to rely on fluctuations—as in breeding for speed in horses, when a thousand co-ordinated structures are involved. A thousand co-ordinated mutations occurring in one individual are almost inconceivable. It seems, then, that natural selection, which works for the benefit of the individual and his race, chooses fluctuations, while artificial selection, which works for the benefit of man, relies largely on mutations.

It is agreed that fluctuations blend. The following then are the rival suppositions:—(*a*) That the inheritance of Mendelian characters is alternate, and (*b*) that only the reproduction of them is alternate; (*a*) that Mendelian characters do not blend, and (*b*) that they do blend (not with the alternate character, but with the similar character, latent or patent in the mate); (*a*) that Mendelian characters are stable and can be eliminated only by selective breeding or by retrogressive mutations, and (*b*) that they fluctuate, and therefore are liable, when useless, to undergo retrogression like other useless characters; (*a*) that the function of sex is to mix characters as marbles of two colours are mixed in a bag, and (*b*) that the function of sex is to blend characters as two paints are blended on a palette (apparently the result of this blending is retrogressive through a preponderance of retrogressive variations; hence the decrease and ultimate disappearance of useless characters, including mutations, whereby the race is stripped of redundancies as an athlete is stripped for a race; in this way, presumably, the life-history of the race has been shortened until recapitulation in development is possible); (*a*) that species and varieties have all originated through mutations, and (*b*) that all natural species and varieties have originated and evolved through the selection of fluctuations, while the selection of mutations has played a great part in the creation of artificial varieties; and finally (*a*) that like does not necessarily beget like when parent and offspring develop under like conditions (for if the doctrine of the Mendelian *inheritance* be true, the pure extracted recessive is by nature unlike the impure dominant parent whence it is derived), and (*b*) that apart from variations, like does exactly and necessarily beget like under like conditions of nurture—for example, a daughter would have developed male traits like her father had her nurture been similar.

Now let us seek crucial examples. Their discovery should not be difficult among the vast collections of facts which have been recorded about living beings. If the *inheritance* (not merely the reproduction) of Mendelian traits is alternate, how is it possible to account for the oft-observed reappearance in *purely bred* domesticated varieties of long-lost ancestral characters? According to Mendelian theory such traits should have been totally eliminated perhaps hundreds, or even thousands, of generations before from the "pure" dominants and recessives that are supposed to have carried on the heritage. As Darwin noted: "We see that in purely bred races [of pigeons] of every kind known in Europe, blue birds occasionally appear having all the marks which characterise *C. livia.*" "Purely bred Game, Malay, Cochin, Dorking, Bantam . . . and silk fowls may frequently be met which are almost identical in plumage with the wild *G. bankiva.*" "Pure" extracted recessives have given dominant offspring, and *vice versa.* Many similar cases might be cited. If "the central phenomenon of Mendelian heredity is segregation," not even the reunion of disunited factors and determiners can account for these reversions; for if the breeding has been *pure,* then reunion, *ex hypothesi,* is inconceivable. In parenthesis, it may be noted that an individual may resemble a remote ancestor in two ways:—(1) He may reproduce a dormant ancestral trait, thereby rendering latent the alternate character which had been patent in his immediate predecessors; or (2) he may, through a failure in nature or nurture, fail to recapitulate the life-history of his race beyond the point reached by an ancestor and by himself as a fœtus—for example, "Occasionally a foal is born with two hoofs on one or more of its limbs; at long intervals a foal appears with three hoofs on one or more of its limbs."

"The fact that the gametes of the cross transmit [or reproduce] each member of the pair pure is as strong an indication as can be desired of the discontinuity between them." If that be so, the converse must be true also—the fact that the gametes of the cross transmit each member of the cross blended is as strong an indication as can be desired of the continuity between them. In other words, if offspring reproduce divergent parents unblended, then there is a presumption that one or other, or both, of each pair of differences arose through mutation; but if there is blending the presumption is that the unlikenesses arose through fluctuation, it may be through the accumulation of many successive fluctuations. For example, since in the crossing of white and black human races eye-colour does not blend, it is probable that this particular unlikeness arose through mutation (and, since British eyes are of many colours, that we are a very hybrid race). On the other hand, since skin-colour blends, it is probable that this colour difference arose through the accumulation of fluctuations. Similarly, if the progeny of racehorses crossed with ordinary horses do not blend hair-colour, but are intermediate as regards speed, the presumption is that the divergency in hair-colour arose through mutation, but that in speed evolved through fluctuations. Now comes the point I am driving at. *When we cross artificial varieties we frequently discover instances of alternate reproduction, especially in traits which are not vital for existence. But when we cross natural varieties (which carry few superfluities) we almost invariably get blending in nearly everything except sex and characters associated with sex (for example, human eye-colour, which is an attraction).* A few years ago there was a beautiful example of blending in the London Zoo in a cross between brown and polar bear, recrossed with the latter. Essentially it was a case of mulatto and quadroon.

But the crossings of natural and artificial varieties reveal another significant difference. Darwin wrote: "Besides visible changes which it [the germ] undergoes, we must believe it crowded with invisible characters proper to both sexes, to both the right and left sides of the body, and to a long line of male and female ancestors separated by hundreds, and even thousands, of generations from the present time; and these characters, like those written on paper in invisible ink, lie ready to be evolved whenever the organism is disturbed by certain unknown conditions. . . . We conclude that a tendency to this peculiar form of transmission is an integral part of the general law of inheritance." But if we study the evidence which Darwin cites and which led him to this conclusion, it becomes plain that he relied altogether on facts derived from artificial varieties. So far as I know (with one doubtful exception, *Kalenchoe flammea* crossed at Kew with *K. Bentii*), there has not been recorded a single instance of the reappearance of a *latent* ancestral trait when natural varieties have been crossed; but the crossing of artificial varieties has revealed multitudes of them. Often they have appeared even when there is no crossing, as in pigeons, fowls, and many plants—hence De Vries's "ever-sporting" varieties.

Of all the foregoing the human race affords excellent illustrations. Man is a natural species, divided into a multitude of natural varieties. Where there has been perpetual war, accompanied by the killing of the vanquished, as in Papua, almost every valley and island has its biologically distinct race. Obviously, lack of intercourse (interbreeding) swiftly produces racial divergence, which steadily increases generation after generation—as witness the great unlikenesses between races separated by great distances, and therefore long durations of time. Human written history has a duration of four thousand years; men are fond of recording wonders; yet never has a useful and persistent human mutation been recorded.

Judging, then, from crucial examples, (1) natural varieties have evolved by way of fluctuations, but artificial varieties in great measure by mutations; (2) there is no Mendelian segregation, but only Mendelian reproduction; (3) blending is universal; and (4) apart from variations (including the results of blending), like, always and necessarily, begets like when parent and child develop under like conditions of nurture.

Surely it is evident that if we use precise language (as Darwin tried to do), and bring all the available evidence into court by means of crucial examples (as Darwin did), the dust which Neo-Lamarckians, Neo-Darwinians, and the rest of the sects have flung into our eyes will be washed away, and our very great man will come into his kingdom again.

G. ARCHDALL REID.

Methods of Improving Visibility.

THE observations of Prof. C. V. Raman (NATURE, October 20, p. 242) on a method of improving the visibility of distant objects by the elimination of reflected light by means of a Nicol's prism placed in the eye-piece of a telescope are certainly interesting, but at the same time they are thoroughly well known, and the idea of increasing the visibility by the elimination of polarised light has received a great deal of attention lately. During the war a considerable amount of experimental work was carried out by the Admiralty in connection with fog-penetration and the beamless searchlight, both of which dealt with polarisation phenomena. It was, however, found advisable to substitute for the Nicol's prism as used by Prof. C. V. Raman a few plates of plain glass placed obliquely at a suitable angle across the axis of the particular instrument, since it is extremely difficult to make really large Nicol's prisms, in addition to which the actual absorption by Nicol's prisms is rather excessive. The matter was also taken up by the late Sir William Crookes, and formed the basis for lenses cut from quartz crystals at right angles to the principal axis, thus utilising the rotary polarising effect of this material. I have lately been using tourmaline for obtaining a similar effect, and I have found that a very thin plate of tourmaline cemented as a semi-lens on to an ordinary pair of spectacles is best for this purpose.

Tourmaline is a mineral that has found a great deal of application lately, and particularly during the war in connection with the piezo effect, in the apparatus used for the detection of submarines and submarine-sounding, and is, in consequence, fairly abundant. For this purpose the plates of tourmaline are cut perpendicular to the vertical axis, but the maximum polarising effect is obtained from plates cut parallel to this axis. Thin plates of this material, when so cut and fixed into the spectacles as mentioned, give an effect the benefits of which can only be realised when put to the actual test. Thus, for example, when fishing, the injurious glare from the water is entirely eliminated. At the same time the eye is able to penetrate the water to considerable depths. This fact will, of course, be appreciated by those engaged in the study of pond-life.

A further application is the manufacture of spectacles for invalids and others residing at the seaside, whereby, again, the glare of the water is almost entirely eliminated and the delightful tone of the tourmaline is very restful to the eye. In photography a further application consists in using a sheet of tourmaline as a light-filter, whereby reflection, and in particular that from shining objects, is largely eliminated; and while it is not possible to take photographs of water directly facing the sun, many pictures which are otherwise impossible can be taken by means of this screen.

A final application, and one with which my experiments originated, was the examination of photomicrographs, which, owing to their delicate nature, were of necessity mounted below a sheet of glass. The continued observation of these objects was found to be a very tedious process owing to the brilliant light required and the consequent reflection from the glass. This reflection was again eliminated by the tourmaline. The plates of tourmaline must, of course, be so mounted that the vertical axis is placed vertically in the spectacles.

These applications have already been provisionally protected at the Patent Office, but up to the present I have found no firm that will take up the manufacture of such glasses. I am confident, however, that a very useful industry awaits the firm with the necessary enterprise.

A. G. LOWNDES.

Marlborough College, Wilts, October 28.

PROF. C. V. RAMAN's suggestion (NATURE, October 20, p. 242) for improving visibility at sea was put forward by me some years ago in "Elementary Seamanship" (Griffin and Co.), and is useful not only for objects above the surface, but for those—like coral-reefs—some little distance below the surface. In the last instance, when there is a slight ripple on the surface of the water it is often difficult to detect them even when navigating with the sun astern. The use of the Nicol prism clears up in a great measure this difficulty.

DAVID WILSON-BARKER.

Flimwell, October 28.

Penial and Genital Setæ of Lumbricus terrestris, L., Müll.

ON p. 172 of Prof. O'Donoghue's "An Introduction to Zoology for Medical Students," reviewed in NATURE of August 11, it is stated that in *Lumbricus herculeus* (the name is a synonym of *L. terrestris*) "in the fifteenth segment the two pairs of ventral setæ lying close to the male external aperture are modified to form the penial setæ." In Bourne's "An Introduction to the Study of the Comparative Anatomy of Animals," vol. 2, pp. 19-20 of the fifth edition, 1912, it is said that in the same worm "the chætæ of the clitellar region differ from those of the rest of the body, being finer and nearly straight, with hooked inner ends. There is also a pair of modified chætæ in somite 15." Borradaile, in "A Manual of Elementary Zoology," p. 217 of the third edition, 1920, says, "The ventral setæ of the clitellum, of the 26th and of the 10th to the 15th segments are straighter and more slender than those of other segments, which are stout and somewhat hooked. The modification is in connection with the use of the setæ of the 26th segment during coition, and of the other straight setæ during the formation of the cocoon in which the eggs are laid." Parker and Haswell, in "A Textbook of Zoology," p. 455 of the second edition, 1910, state that "the setæ in the clitellum, and those in the neighbourhood of the genital apertures, are much slenderer than the rest."

Systematic writers, however (to whom modifications in the form of the setæ are of importance as furnishing specific characters), do not appear to have recognised the presence of penial setæ in segment 15 of *Lumbricus terrestris*. Thus Beddard, in "A Mono-